

DEVICE FOR EXTRACTING WATER FROM AIR

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ABSTRACT : *This paper provides a method for extracting water from atmospheric air.. According to a UN report, the global demand for freshwater will exceed supply by 40% in 2030. Due to a number of factors like climate change, rapid growth in population and massive urbanization. An AWG system uses a method in which we condense the water present in atmospheric air by bringing it below its dew point. There are other methods by which we can extract water from the air like the use of Peltier effect, wet desiccation. Here we use vapor compression refrigeration cycle with the help of compressor. This system is most effective in areas where relative humidity is high and in coastal areas.*

Keywords: Atmospheric water generator, United Nation.

1. INTRODUCTION

Due to a number of factors like climate change, rapid growth in population and massive urbanization. Today over 1 billion people lack to access to clean drinking water. Many Indian cities and states face a serious water crisis. India's silicon valley Bengaluru is ranked 2nd among 11 cities likely to run out of the water. Antiquated plumbing wasting over 50% drinking water, where water from lakes not suitable for drinking or bathing. Unplanned urbanization and encroachment have decreased a total number of cities water bodies by 79%. The water table has shrunk from 76-91 meters to 10-12 meters in 2 decades. Cape Town of South Africa is the first modern city to run out of the water, the crisis is due to 3 years of very low rainfall and increasing consumption due to growing population. If proper conservations are not carried out over 5 billion people will face problem in access to proper adequate drinking water by 2050. Several states face water crisis in India, largely due to the fact that groundwater is fast depleting, rivers too are running dry. Nearly 55% of country's water wells have gone dry and 54% decrease in groundwater table. According to a World Bank report in the last 20 years, more than 3 lakh people have committed suicide due to drought. Due to improper distribution methods tons of water is wasted every day across

cities. At the current rates, about 40% people in India may not have water to drink by 2030.

So here we try to bring awareness to people by practically producing water by using latest engineering techniques. The water produced using this device can be used for irrigation processes and other human usages after using proper water filtration and purification methods. Upgrading our self with day to day practices can bring a great impact on the situation.

So, this project will be helping to extend the applications of such devices further in the near future. According to previous knowledge, we know that the temperature requires to condense water is known as dew point temperature.

2. METHODOLOGY

This paper uses a methodology of the refrigeration cycle for extracting water from air present in the surroundings. The refrigeration method uses a compressor for increasing the pressure of the refrigerant and temperature of the refrigerant is constantly increased and the hot refrigerant passes through condenser coil and cools down its temperature. Then the refrigerant is passed through the capillary tube, where it changes its phase and cool down to extremely low temperature.

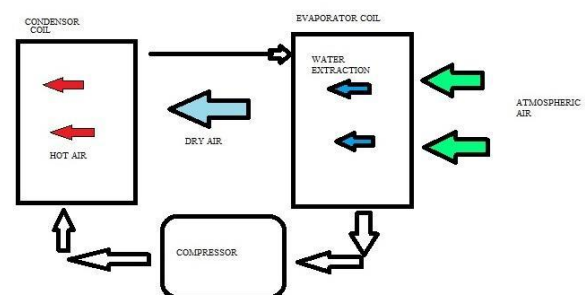


Figure 1: WATER EXTRACTION PROCESS

This low-temperature refrigerant is passed through the evaporator coil where it cools the surrounding and the

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refrigerant again flows through the compressor and cycle continues.

Here we are setting up a fan system which passes constant air supply to the evaporator coil. Water present in air as humidity is extracted by bringing the air temperature below its dew point. The water condenses from air and water is extracted. The compressor is provided with a temperature sensor controller which constantly monitors the temperature of the model and it switches off the compressor when reaches its freezing point. This prevents the formation of ice in the coil.

A. Refrigeration cycle

Refrigeration is the process of transferring heat from a low temperature to a high temperature. The purpose of the refrigerant is to remove heat from low-temperature medium.

B. Dew Point

The temperature below which air condenses and water droplets are formed.

3.Amount of water (in L) present in 1m³ of air for different humidity and temperature conditions

Relative Humidity (RH) is the ratio of partial pressure of water (P_w) to that of saturation pressure (P_s)

$$RH = (P_w/P_s) \times 100$$

Saturation pressure (P_s) and relative humidity (RH) data partial pressure of water (P_w) can be obtained from the formula

$$P_w = (RH/100) \times P_s$$

Humidity Ratio gives the volume of water (in m³) present in 1m³ of air. Humidity ratio can also be expressed in terms of partial pressure of water (P_w)

$$\text{HumidityRatio} = 0.622 \times [w/(P_a - P_w)]$$

(Where P_a is the atmospheric pressure i.e. $P_a = 1.01325$ bar)

Humidity ratio gives the amount of water (in m³) present in 1m³ of air

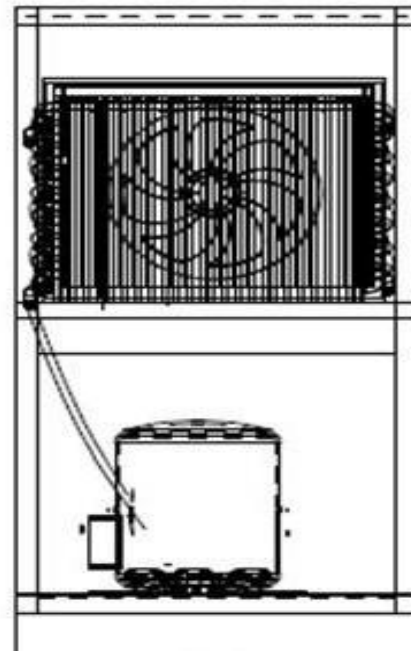


Figure 2: Front view of prototype

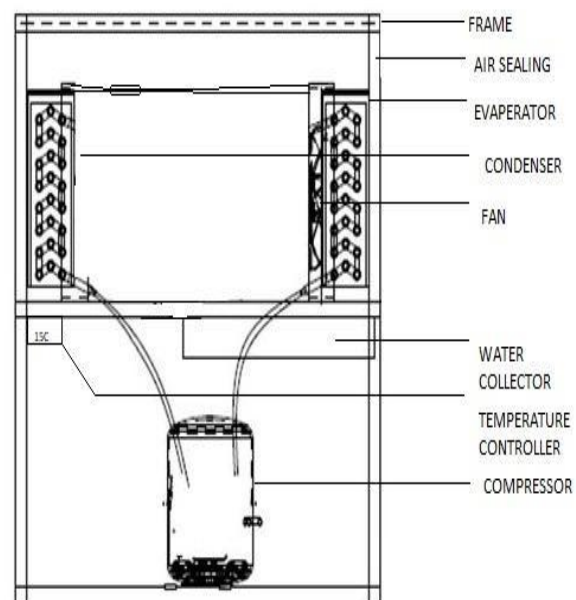


Figure 3: Components of the model.

3.Configuration of the model

- Frame: 65*36*38 cm , cast iron.
- Fan (2 nos): Plastic, 400 RPM, 80mm, AC 210-230V, 50HZ, 0.19AMP.
- Heat Coils: MATERIAL=Copper, air cooled, U-FLANGE, Diameter - ½ inch , Dimension 12 SQ inch.
- Compressor: Power Cool Motor Compressor, Motor Type: RSCR, 120kg .Rating-230v, 50hz, 145watts , 1 phase , PTC Motor Starter.
- Refrigerant : R134a (1,1,1,2Tetrafluoroethane).
- Temperature Sensor : Range (-40 to 99 °c), DIGITAL PROCESS CONTROLLER sz-7510T, 230 V.
- Capillary tube: copper, 2.5 meters

4.Component details

Refrigerant: R134a is an HFC refrigerant. It is a nontoxic refrigerant which is extensively used in household and commercial refrigeration systems. We use refrigerant in our system as it has a low boiling point and it can change its phase easily from gas to liquid. It is more environmentally friendly compared to CFC's and HCFC's and does not deplete the ozone layer. It is widely recognized as a good replacement for the refrigerant R12.

Compressor: Compressor is an important component of our system. It is used to compress the gas. Thereby increasing the pressure along with the boiling point. Here we use a power cool motor compressor. We use a drier to protect the compressor from liquid entering it. A compressor is also responsible for continuing the cycle by taking in gas from the evaporator compressing it again and sending to the condenser.

Evaporator: It is the part where we obtain water. In this system, we use two evaporators. Most of the water is extracted in the 1st evaporator and remaining in the 2nd evaporator. The evaporator is also a heat exchange system where cool air is transferred to the surrounding air which cools the atmospheric air below its dew point leaving fresh water. We use an axial fan for drawing the atmospheric air into the evaporator

Condenser: From the compressor, the hot gas goes into the condenser where it exchanges heat from the atmosphere and becomes cool. Here we use a fin-type copper condenser. We use one elongated condenser along with two evaporators in this machine. Condensers are also used behind refrigeration systems to transfer heat to the surrounding

Temperature Process Controllers: It is used to maintain the temperature in the evaporator and to protect from extreme temperature and also to prevent the formation of frost. It shuts the compressor when the temperature goes below a certain temperature. It is a necessary equipment in our systems. We use a digital process controller of 230V with a temperature range from (-40 to 99 degrees Celsius)

Frame: The frame is made of cast iron. It is made in a way to withstand the weight of the components inside. It is painted to avoid rust formation. It is a compact system and houses both the evaporator and one condenser. The compressor is kept below the frame. A few mechanical properties of cast iron include hardness, toughness, ductility, malleability, tensile strength.

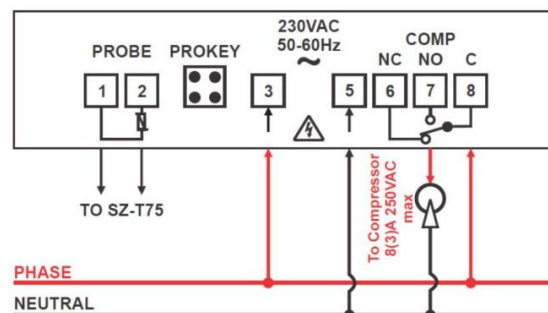


Figure 4: Wiring diagram for temperature controller.

5. PROGRAMMING OF TEMPERATURE CONTROLLER

Here we use digital temperature controller for automatic on and off of the compressor. All required parameters are programmed in controller in a way that it automatically switches off the compressor when it reaches the given low temperature value and set points. This is to ensure minimum frosting of evaporator coil.

All the below given set points were programmed in temperature controller using multiple keys available in the device for required output functions.

Sr. No.	Para.	Description
1	Set Point	Compressor relay set point.
2		Set other parameter.
3	P1	Set Heating or Cooling mode.
4	P2	High temperature limit.
5	P3	Low temperature limit.
6	HS	Maximum Set Point limit.
7	LS	Minimum Set Point limit.
8	P4	Differential for compressor relay ON condition.
9	P5	Probe calibration.
10	P6	Time delay (compressor relay restart after cutoff).
11	Ot	Minimum ON time for compressor relay.
12	E1	Compressor relay status in probe fail.
13	Cn	Compressor relay OFF time during probe fault.
14	Cy	Compressor relay ON time during probe fault.
15	dd	Delay the display of temperature.
16	Ad	Time delay at Power ON for alarm indication.
17	PO	Enable / disable Power ON/OFF.
18	PA	Change Password
19	LP	Keypad Lock
20	FS	Restore factory defaults
21	EP	End Programming

Figure 5: Temperature Controller set point parameters.

6. RESULTS

The model is tested in different environmental conditions with different atmospheric temperature and relative humidity. The model is tested in open surroundings as the air circulation and levels of atmospheric humidity are present greater in open area compared to the closed room surroundings.

Table 1: Result of experiment carried out in Chennai on 20:03:2018,R.H-60%

Time of Operation	Water Generated(ml)
05:00 AM – 07:00 AM	180
08:00 AM – 10:00 AM	220
11:00AM-01:00PM	230
TOTAL TIME:6 HOURS	Total Water=630ml

Table 2: Daily average humidity of south Indian cities

Place	State	R.H%
Chennai	Tamil Nadu	70
Bangalore	Karnataka	65
Hyderabad	Telungana	56
Port Blair	Andaman & Nicobar	79
Thiruvananthapuram	Kerala	78
Vishakhapatnam	Andhra Pradesh	72

CALCULATION:-

Total time of operation=360 min
 Total amount of water generated = 630 ml
 Amount of Water collected per minute of operation= $630/360=1.75$ ml/min

After conducting the experiment in Chennai city having average relative humidity 60% we got 1.75 ml of water per minute.

Amount of water generated per day of operation= $1.75*60*24=2520$ ml.

Amount of water generated per year of operation= $2.52*360$ litres = 907.200 litres per year.

APPLICATION

- AWG can be used for reducing the indoor humidity as it acts as a dehumidifier.
- We can create water even in remote areas even in places with less ground water level.
- It can be used during emergency situations and for military usage.
- Can be used for highway toilets where water is not readily available.

7.CONCLUSION

After testing it is concluded that it is practically possible to generate or extract water from the humidity of the air. Further development of the technology can serve water crisis in remote areas. Water produced in this method can be used for irrigation purpose or human consumption after following some water purification and filtration techniques.

8.REFERENCES

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